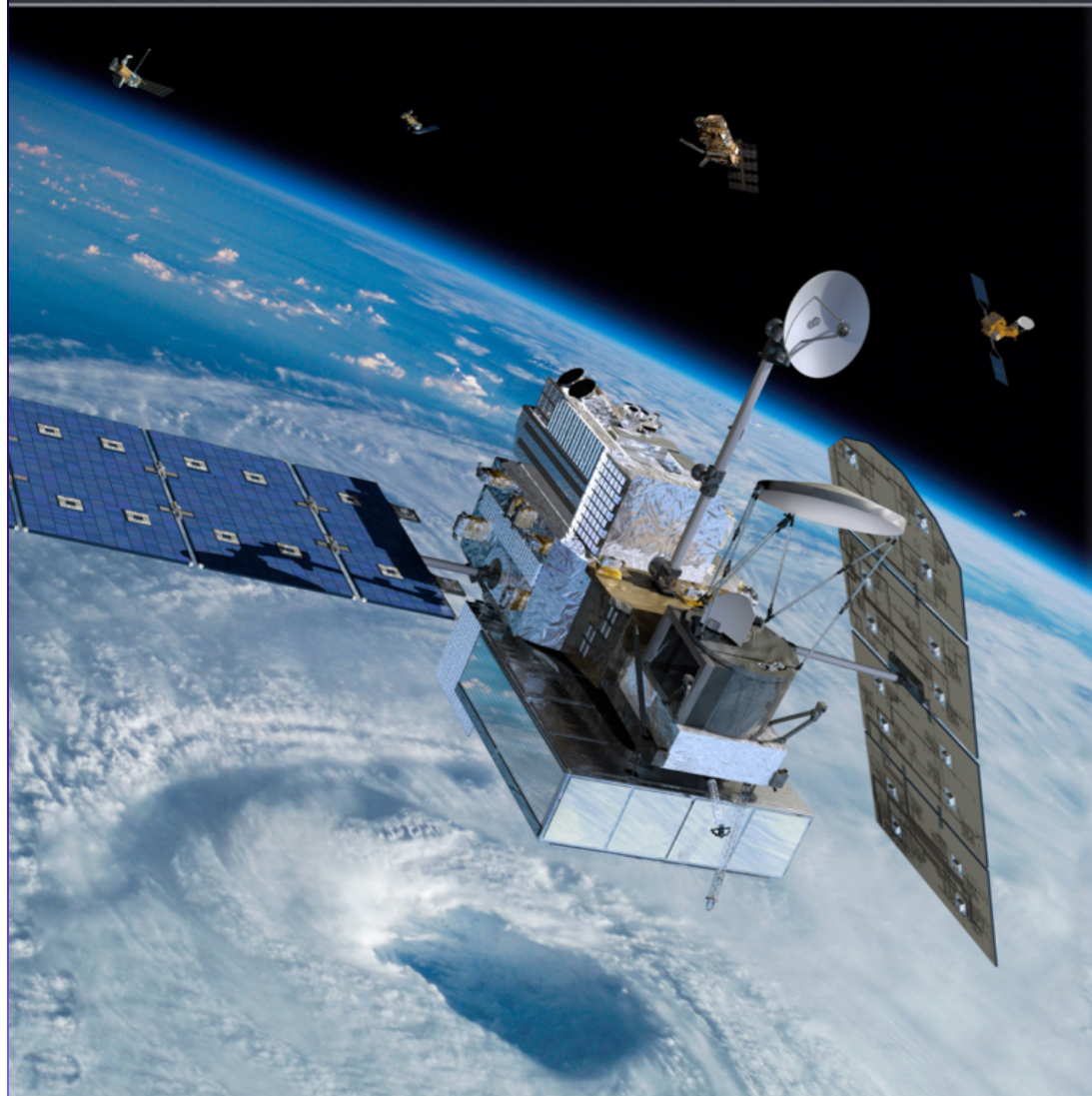




Connecting Space-Based Precipitation Observations with Society - A Reservoir for Applications Users



Dalia Kirschbaum

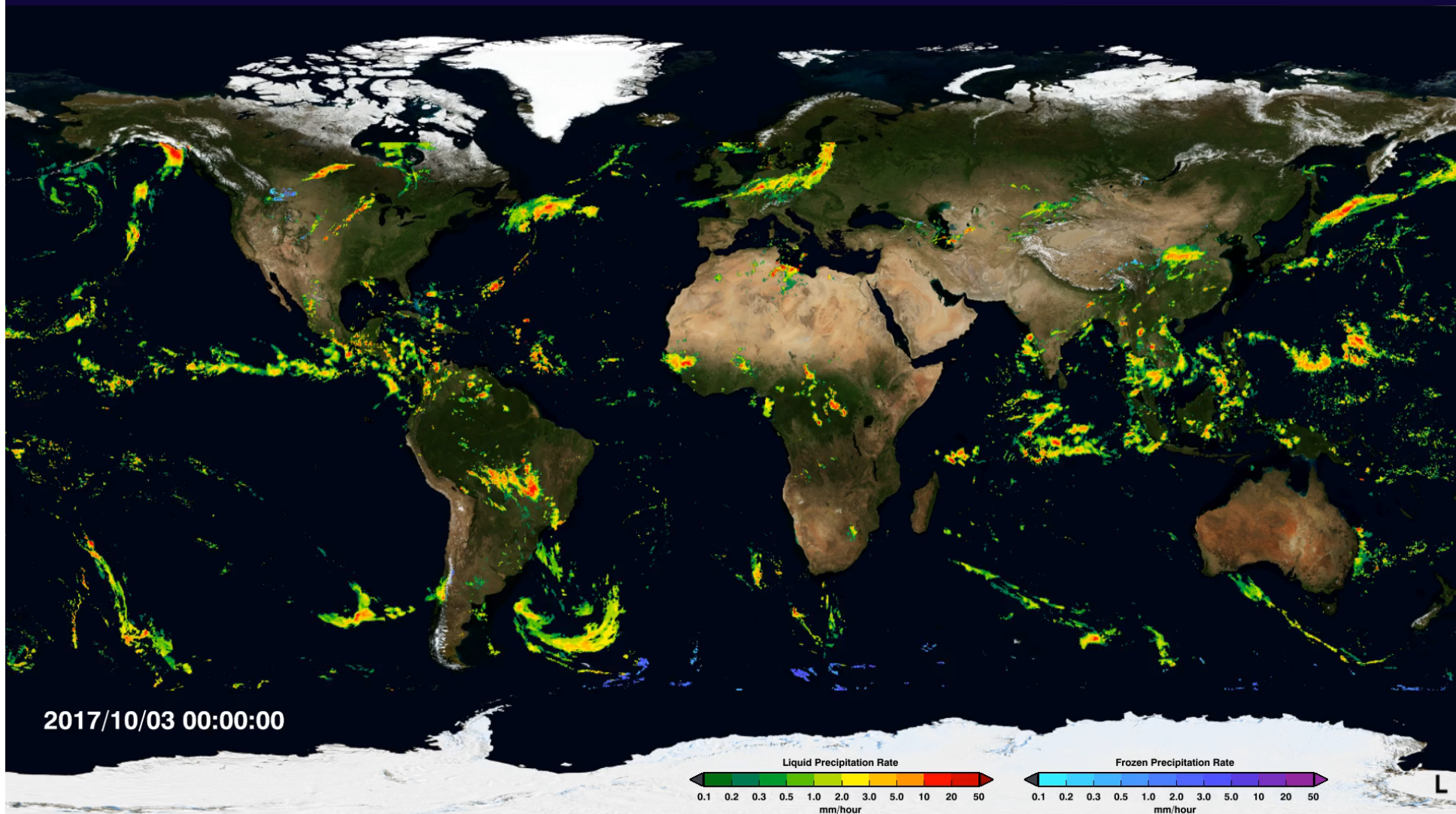
GPM Deputy Project Scientist
for Applications

dalia.kirschbaum@nasa.gov

NASA /GSFC

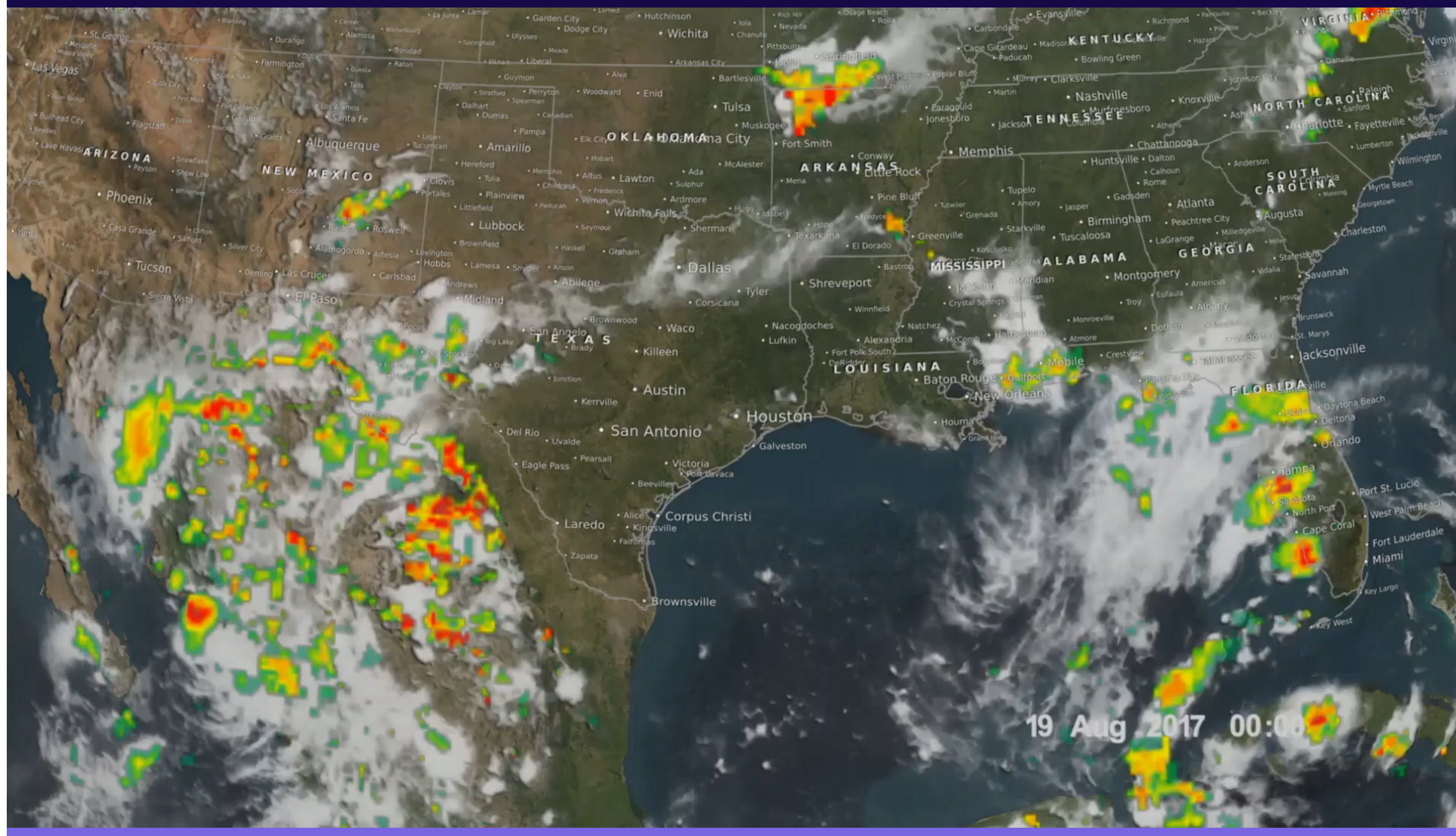


Last Week: IMERG Data



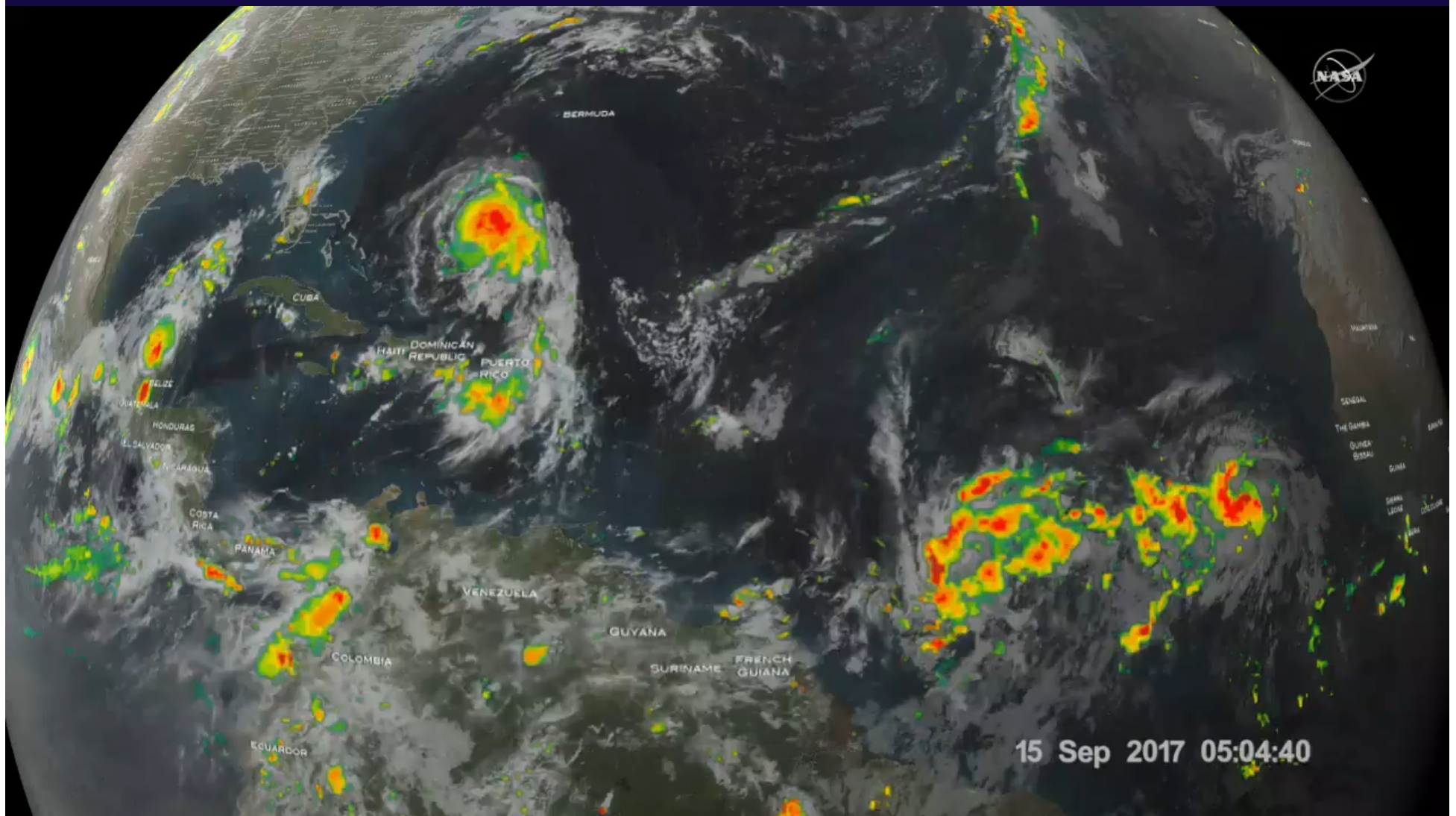


Tropical Cyclone Harvey – August/September 2017



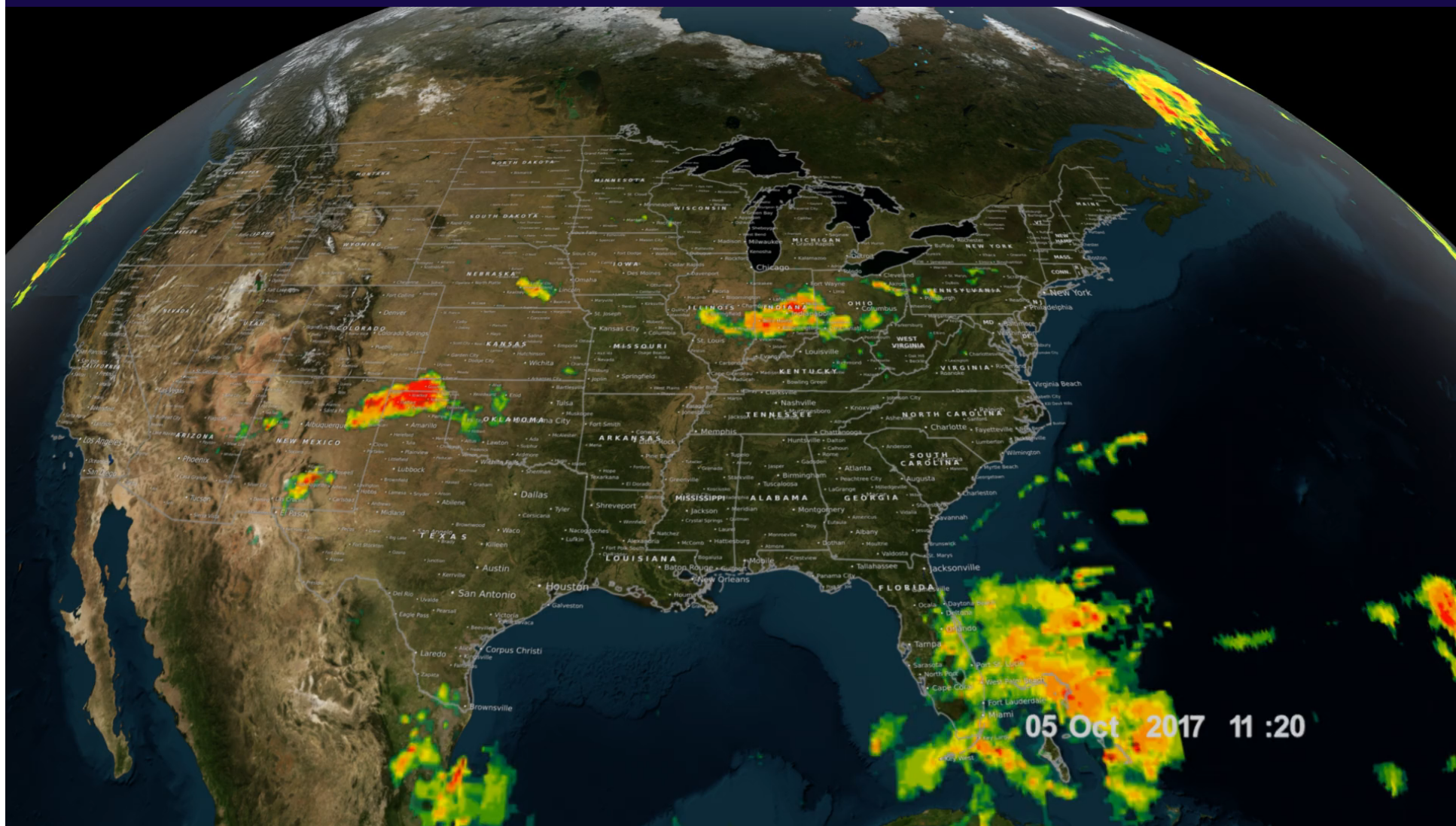


Hurricanes Jose and Maria – September 2017





Hurricane Nate, October 2017





GPM Applications Overview and Objectives

1. **Increase awareness** of GPM and TRMM applications focusing on both broad areas and targeted thematically-focused communities
 - BAMS paper (*published June 2017*)
 - One pagers and videos outlining GPM applications examples: floods, public health, agriculture, and tropical cyclone forecasting
 - Extensive outreach effort and demonstration of how end users are working with the data
2. **Engage users communities** in trainings, workshops, and case studies to improve awareness and use of data and gain feedback in how the data products are used for decision making
 - Webinar training sessions (2015-16) introducing GPM data
 - Stakeholder workshops (Agriculture, Water, Disease)
3. **Improve data access** and visualization of core GPM products for rapid ingestion and analysis
 - New visualization and data access capabilities
 - Updated Data Access Portal: <https://pmm.nasa.gov/data-access>



Societal Benefit Areas



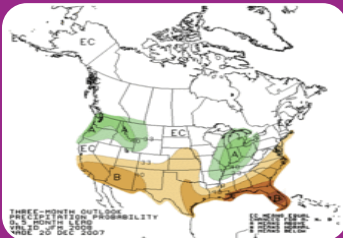
Extreme Events and Disasters

- Landslides
- Floods
- Tropical cyclones
- Re-insurance



Water Resources and Agriculture

- Famine Early Warning System
- Drought
- Water Resource management
- Agriculture



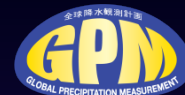
Weather, Climate & Land Surface Modeling

- Numerical Weather Prediction Modeling
- Land System Modeling
- Global Climate Modeling

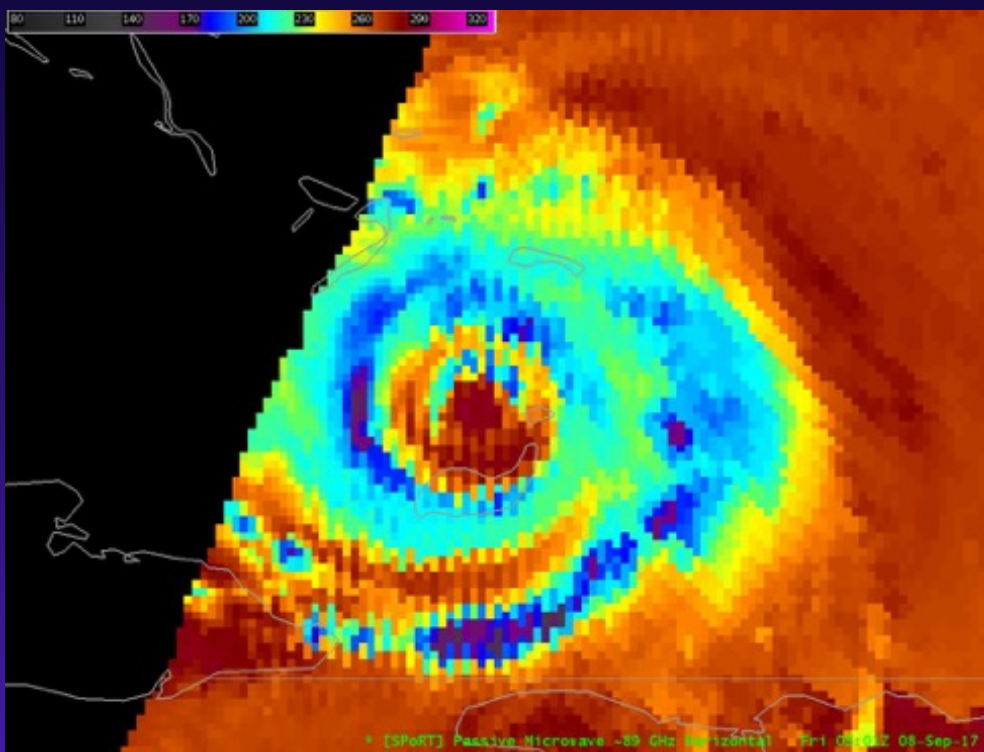


Public Health and Ecology

- Disease tracking
- Animal migration
- Food Security



Monitoring Irma with GPM

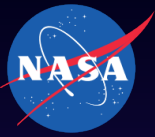


Hurricane Irma Discussion Number 37
NWS National Hurricane Center Miami FL AL112017
500 AM EDT Fri Sep 08 2017

Microwave images and data from an Air Force Reserve Hurricane Hunter aircraft indicate that Irma is currently undergoing an eyewall replacement cycle. A recent GMI overpass showed an 50 nmi wide outer eyewall, with the inner eyewall weakening. The Hurricane Hunter aircraft reported peak 700-mb winds of 147 kt in the outer eyewall near 0500 UTC, and maximum SFMR winds were in the 125-130 kt range. Based on these data, the initial intensity is reduced to 135 kt.

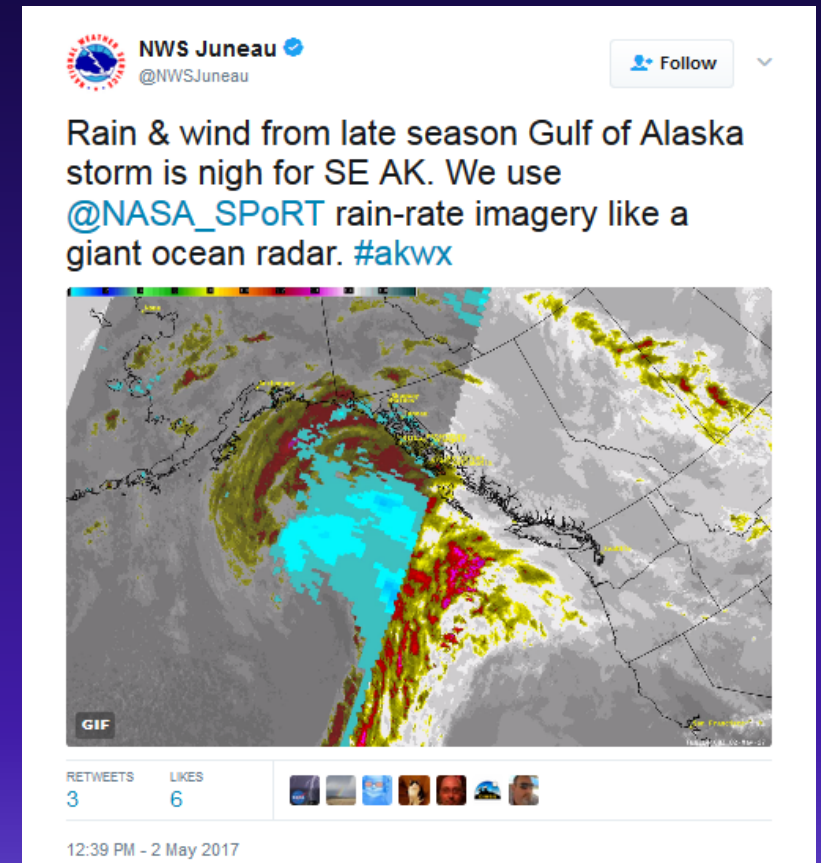
Imagery from the Global Precipitation Measurement (GPM) and GPM Microwave Imagery (GMI) mission is provided to NOAA's National Hurricane Center through NASA's Short-term Prediction Research and Transition (SPoRT) Center, which transitions NASA, NOAA, and other partner data to operational weather forecasting partners.

Imagery from GMI was used by the National Hurricane Center to understand the state of Irma on Friday, September 8 as it moved north of Cuba. GMI observations documented an eyewall replacement cycle that impacts the intensity and development of the storm.



GPM data used by Alaska National Weather Service Forecasting Office

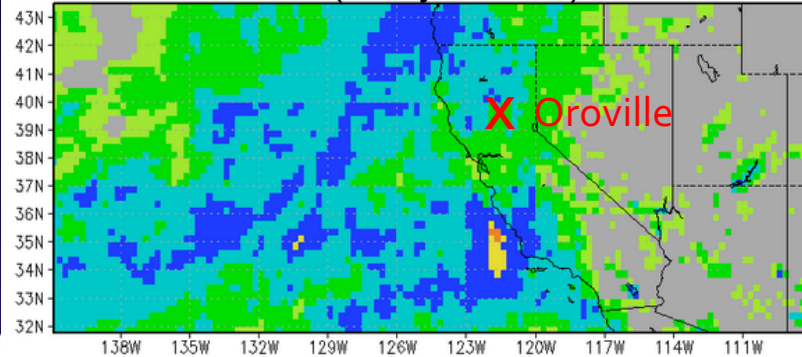
GPM L2 rain rate products are being routinely ingested by the NWS office in Juneau, AK. The NASA SPoRT team provides the **GPM retrievals directly to their AWIPS decision support system** (shown in the tweet) and has also provided training and assessment of the products to demonstrate **applications in southeastern Alaska**. A recent training session held in Alaska also introduced fire managers to GPM and other NASA products for improved situational awareness during the Alaska fire season.



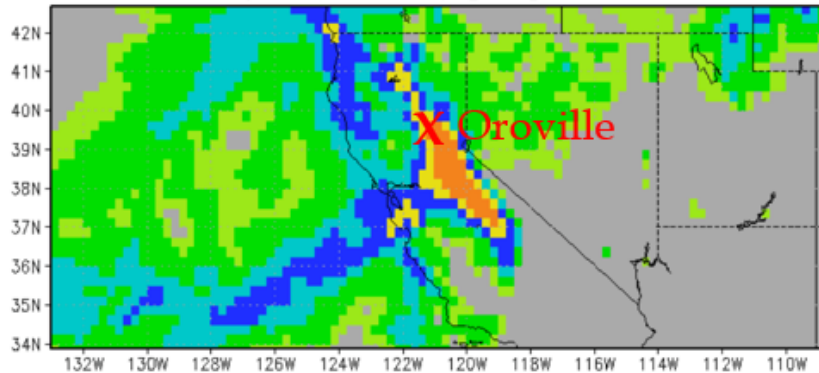
Credit: Anita LeRoy (MSFC/UAH), Matt Smith (MSFC/UAH), Frank LaFontaine (MSFC/Raytheon), Brad Zavodsky (MSFC), and NWS Juneau

Flood Estimation for Oroville Dam, February 2017

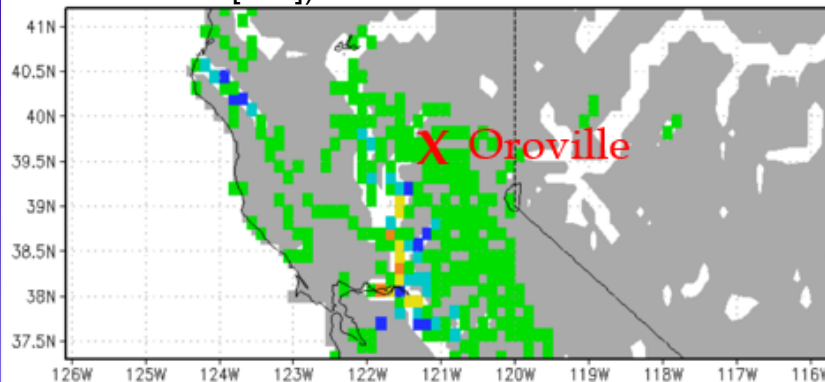
IMERG Rainfall (7-day accum.) 21 Feb 2017



GEOS-5 Rainfall Forecast (3-day accum.) 22 Feb 2017



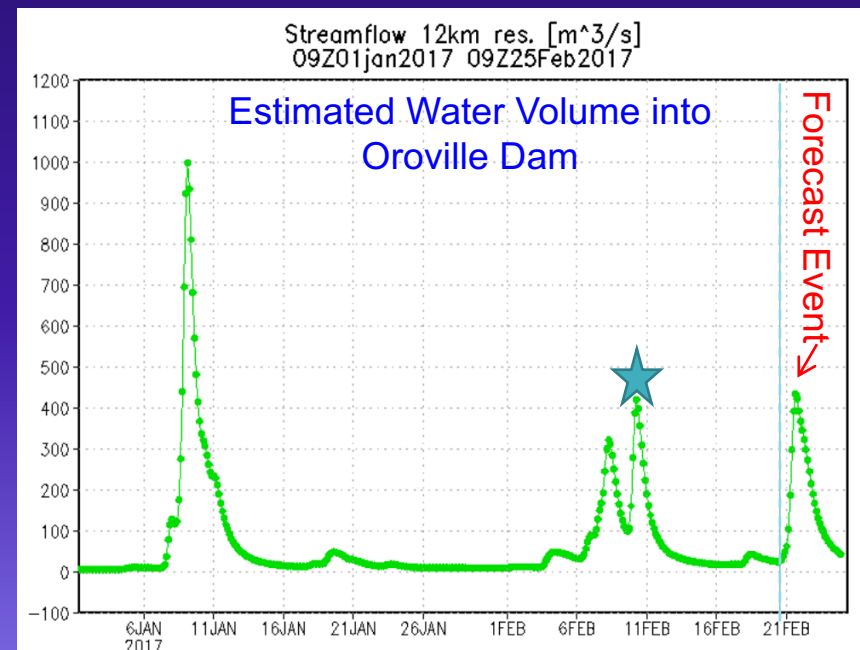
Flood Detection/Intensity (depth above threshold [mm]) Forecast for 22 Feb 2017



View of Oroville Dam's main spillway (center) and emergency spillway (top), February 11, 2017.



The Global Flood Monitoring System (GFMS) uses GPM to detect potential flooding conditions and estimate intensity. These show estimates of water volume into the Oroville Dam in Jan-February, 2017

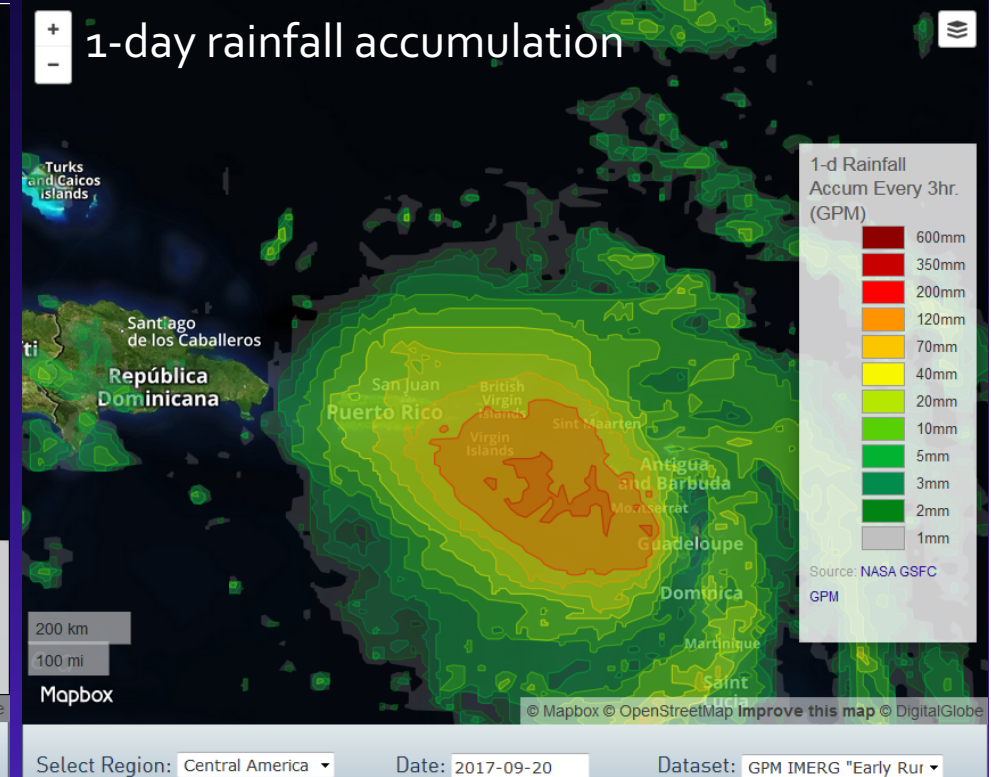




Landslide hazard potential for Hurricane Maria – Sept 20th, 2017



<https://pmm.nasa.gov/precip-apps>

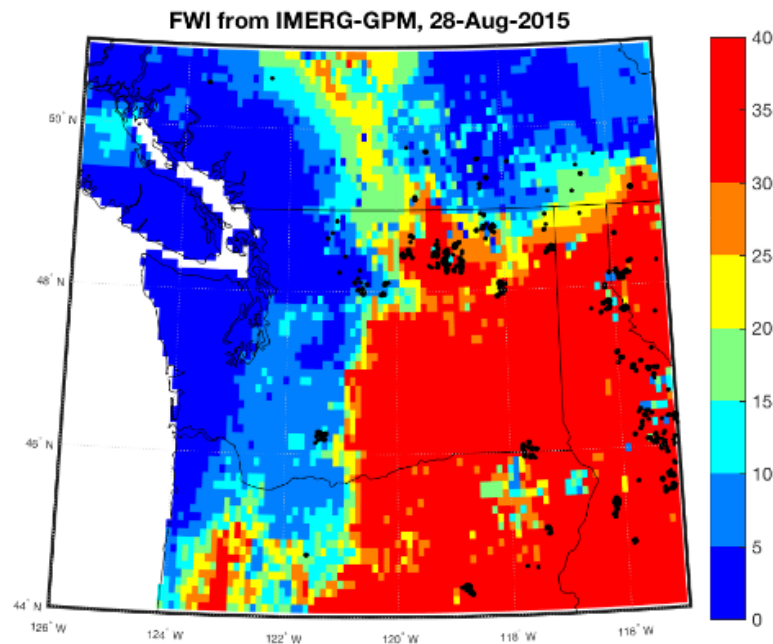


- Data from the Global Landslide Hazard Assessment for Situational Awareness (LHASA) model was/is routinely used by the National Guard for situational awareness for Hurricane Maria, the city of Rio de Janeiro, Pacific Disaster Center, FEMA and others

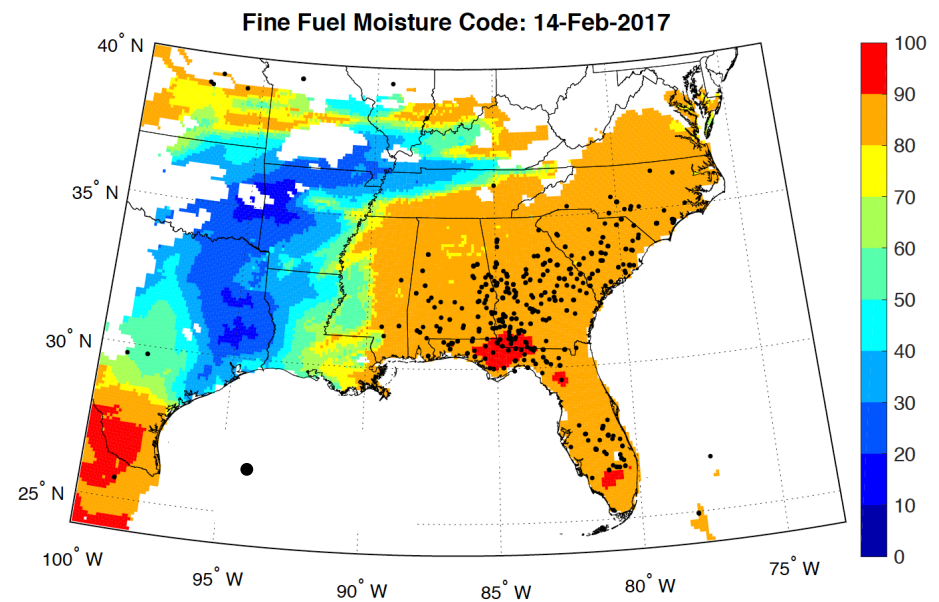


Global Fire Weather Data and Forecasting

The Fire Weather Index System is the most widely used fire danger rating system in the world. The Global Fire WEather Database (GFWED) developed at NASA GISS integrates different weather factors influencing the likelihood of a vegetation fire starting and spreading.



The Fire Weather Index tracks the potential for extreme fire behavior, seen here with Aqua & Terra MODIS active fires, using GPM IMERG for Aug 2015 record-breaking Pacific Northwest wildfires (Field, Engel Marlier, Lettenmaier)



The Fine Fuel Moisture Code tracks the potential for fire starts, such as these predominantly agricultural and forest plantation prescribed fires in the southeast US.

R. Field/NASA GISS

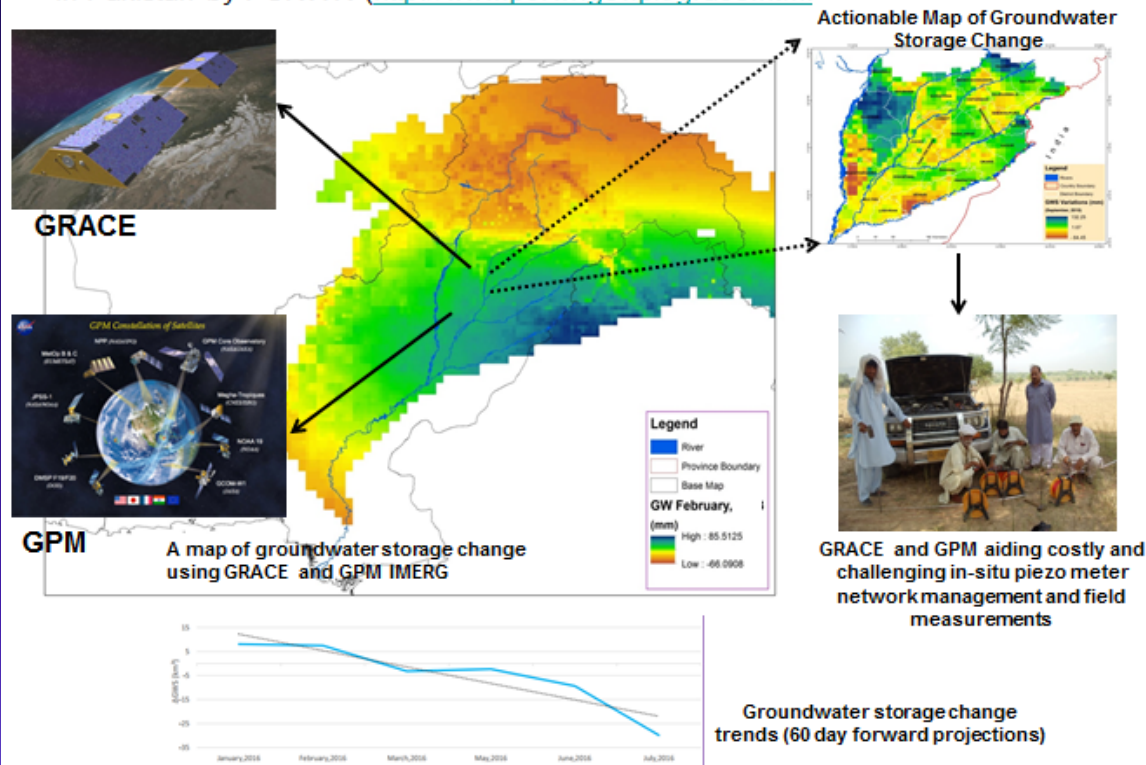


Satellite data used to empower National Water Agencies of Pakistan and Nepal



Over 10,000 farmers in the Indus basin receive information on water resources in their area on their cell phone

Operationalization of GRACE and GPM for Seasonal Groundwater Management in Pakistan by PCRWR (<http://www.pcrwr.gov.pk/grace.html>)

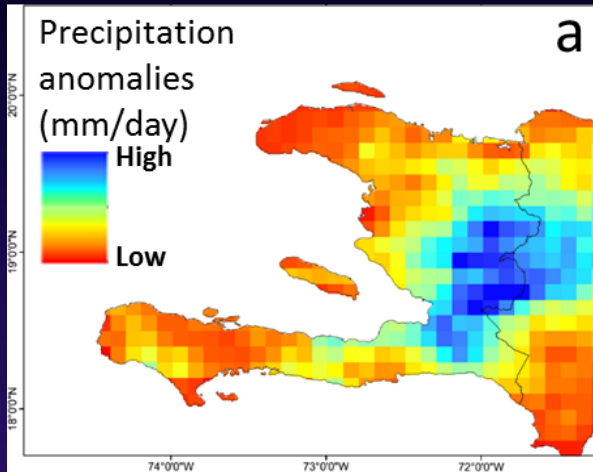


Banana farmer checking his IMERG-based irrigation advisory

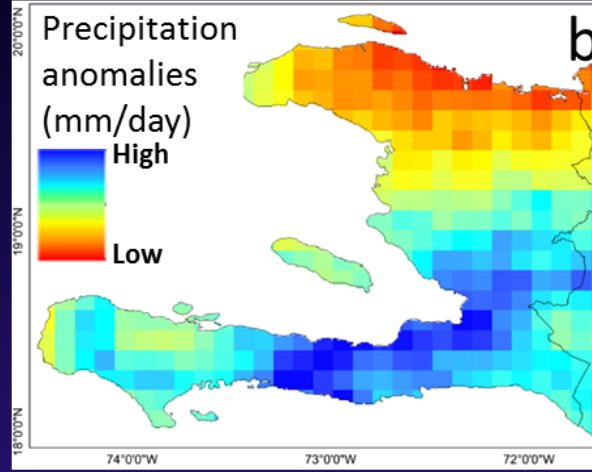


“Dear farmer friend, we would like to inform you that your wheat crop does not need irrigation due to sufficient rainfall during the past week.”

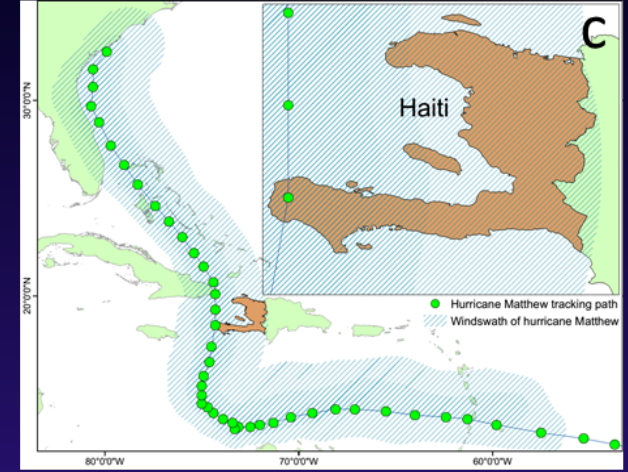
Cholera Risk prediction after Hurricane Matthew, October 2016



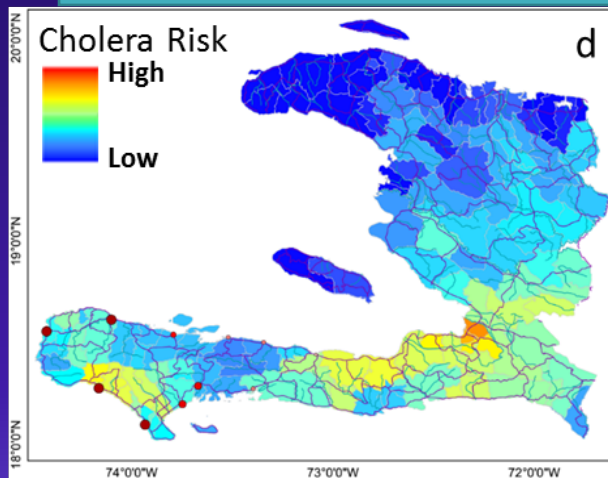
September precipitation anomalies



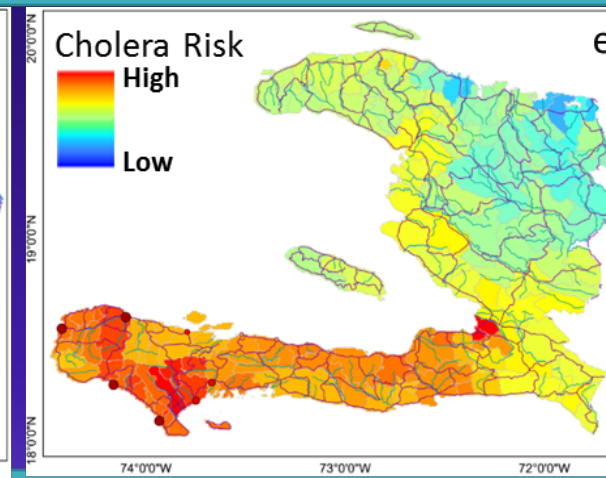
(Sept1-Oct13) precipitation anomalies



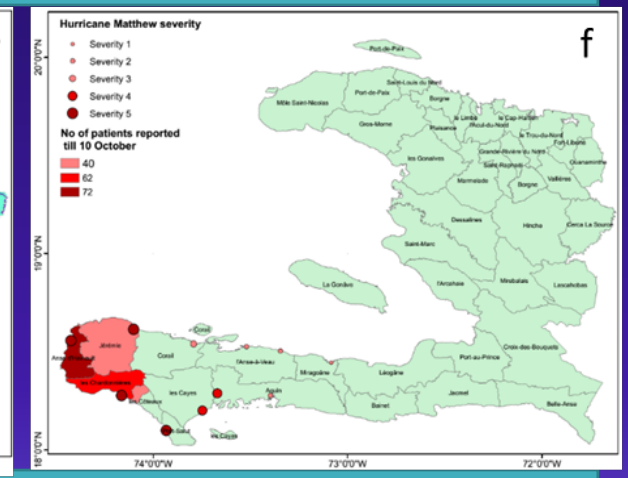
Hurricane Matthew track over Haiti



Cholera risk map based on pre hurricane hydro-climatic condition



Cholera risk map based on 2 weeks post hurricane hydro-climatic condition



Cholera condition in Haiti until 10 October

GPM IMERG data was used along with air temperature anomalies and population to compute maps of estimated cholera risk in Haiti following the passage of Hurricane Matthew 1-2 October, 2016. Plots show a) IMERG precipitation anomalies prior to and b) following Hurricane Matthew; c) track forecast for Matthew over Haiti, d) shows a Cholera risk map based on pre-hurricane hydroclimatic conditions, e) updated Cholera risk map 2 weeks after Hurricane Matthew, and f) reported cases of Cholera as of 10 Oct 2016.



Publications

NASA'S REMOTELY SENSED PRECIPITATION

A Reservoir for Applications Users

DALIA B. KIRSCHBAUM, GEORGE J. HUFFMAN, ROBERT F. ADLER, SCOTT BRAUN,
KEVIN GARRETT, ERIN JONES, AMY McNALLY, GAIL SKOFRONICK-JACKSON,
ERICH STOCKER, HUAN WU, AND BENJAMIN F. ZAITCHIK

NASA's precipitation measurement missions provide critical precipitation information to end users that improves understanding of Earth's water cycle and enhances decision-making at local to global scales.

Kirschbaum, D. B., and Coauthors, 2017: NASA's Remotely-sensed Precipitation: A Reservoir for Applications Users. *Bull. Am. Meteorol. Soc.*, June, doi:10.1175/BAMS-D-15-00296.1. <http://dx.doi.org/10.1175/BAMS-D-15-00296.1>.



Engage users communities

1. Trainings

- Webinar training sessions (2015-16) introducing GPM data

2. Workshops

- Stakeholder workshops (Agriculture, Water, Disease)

3. Informal PMM Applications Working Group

- Provides guidance on new directions

4. Case studies: Starting soon!

- Improve awareness and traceability of data through the decision making pipeline and gain feedback in improving data and access pipelines



World Bank Water Training

The Earth Observer

May - June 2017

Volume 29, Issue 3

13

NASA-World Bank Workshop on Global Precipitation Measurement Applications

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Mitchell K. Hobish, Sciential Consulting, LLC, mkh@sciential.com

Alan B. Ward, NASA's Goddard Space Flight Center, Global Science and Technology, Inc., alan.b.ward@nasa.gov

Introduction

NASA and the World Bank convened a workshop on Global Precipitation Measurement (GPM) Applications on March 22, 2017, at the School of Public Health at George Washington University, in Washington, DC. Twenty-seven participants from the World Bank, primarily from the Environment and Natural Resources Global Practice group, as well as six representatives from NASA, participated in this three-hour workshop, which the World Bank hosted. The workshop was organized to engage the water-management community at the World Bank and increase awareness of NASA's water resources data—specifically focusing on precipitation. Other goals of the workshop were to promote a dialogue on the barriers or challenges to using these data on the World Bank side as well as at the client/user level, and to discuss the opportunities for increasing capacity to utilize remote sensing products for improved situational awareness and decision making at the practitioner level.

Following a brief introduction to the GPM mission and the reason for its implementation, the results of this workshop and discussion are summarized below.

GPM Overview

The GPM mission¹ is a joint venture between NASA and the Japan Aerospace Exploration Agency (JAXA). It is currently comprised of a constellation of nine satellites, with instruments that measure rain and falling snow characteristics every three hours, and to provide information on Earth's water and energy cycles. GPM is a science mission with integrated applications goals. Data from the GPM mission have been used for a broad range of applications across different societal benefit areas, including water resource management, disaster response, public health, ecological monitoring,

the American Meteorological Society²), all of which have the goal of advancing the use of GPM and its predecessor Tropical Rainfall Measuring Mission (TRMM) data to support decision making and improve situational awareness across different sectors at local-to-global scales.

Workshop Executive Summary

The NASA-World Bank GPM Applications Workshop focused on the topic of water resources and how NASA data and products may be utilized within projects relevant to the participants. The agenda featured presentations from NASA and the World Bank, where a new NASA-World Bank developed e-book was introduced. There was then an hour-and-a-half long discussion session where World Bank and NASA representatives had lively break-out discussions focusing on a few key questions. At the workshop participants classified themselves as novice or intermediate users of remote sensing data, but were highly engaged in discussing potential opportunities for building the capacity of using such data at the client level. There was a continued thread of discussion on how to best "train the trainers" at the end-user/practitioner level, with the goal of demystifying the use of remote sensing data for users through focused trainings. Results of this workshop and discussion follow.



Discussion Summary

For the discussion section of the workshop training, participants were divided into four groups, each led by a NASA or World Bank representative and in most cases a rapporteur. The discussion questions posed to the group were:

1. What information do you and/or the end users with whom you will share this information typically use to make decisions? Are any of the resources that you/they rely on based on remotely sensed data? What types of decisions do you and/or the end-users make? What is the process that is followed when making decisions?
2. What are some challenges that you foresee in using these data and resources? How might some of these challenges be addressed to remove some of the potential barriers?
3. What are the new opportunities that you see after being introduced to the resources we shared today? How might these data or products be useful in your/their work?

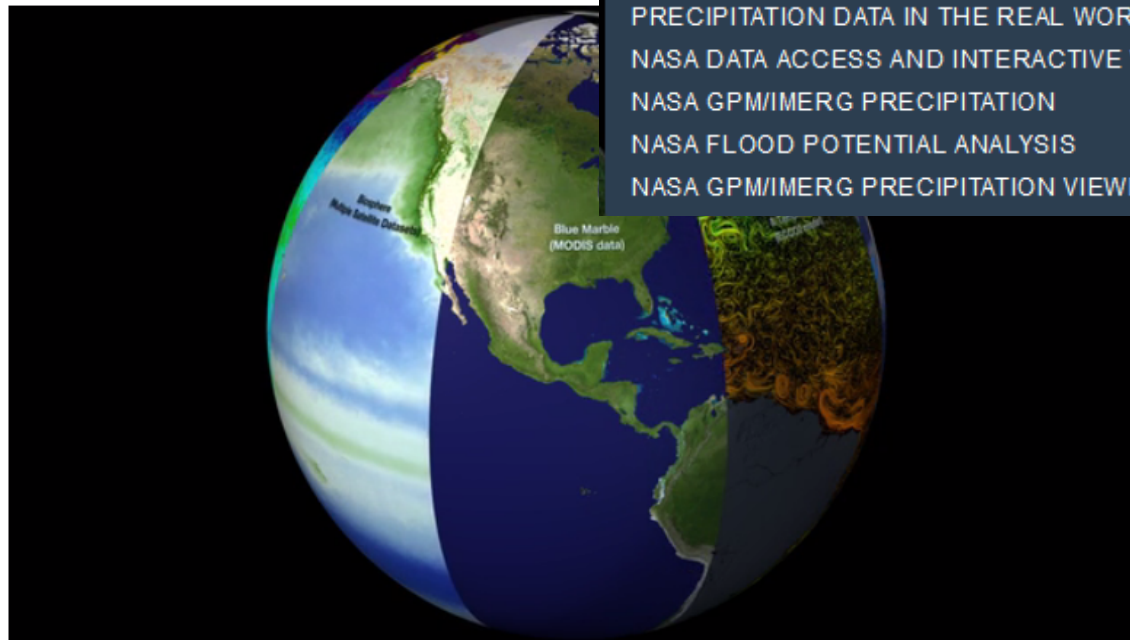


Water Resources e-book

EARTH OBSERVATIONS OF WATER RESOURCES E-BOOK

EARTH'S WATER

MEASURING PRECIPITATION: ON THE GROUND AND FROM SPACE
COMBINING EARTH OBSERVATIONS TO GAIN A GLOBAL PERSPECTIVE
PRECIPITATION DATA IN THE REAL WORLD
NASA DATA ACCESS AND INTERACTIVE VIEWERS
NASA GPM/IMERG PRECIPITATION
NASA FLOOD POTENTIAL ANALYSIS
NASA GPM/IMERG PRECIPITATION VIEWER



<http://www.appsolutelydigital.com/Nasa/>



GPM Agricultural Applications Workshop

- August 1st, 2017- NASA and the World Resources Institute co-hosted a one-day workshop focused on current applications and potential opportunities for use of satellite-based water resource data and other tools to support decision making in the context of agricultural management and food security
- 80 participants from across a broad spectrum of organizations including government, private companies, NGOs (Field to Market, OXFAM), and other organizations including the Gates Foundation
- The agenda, presentations and follow up materials on this workshop are available at <https://pmm.nasa.gov/meetings/2017-gpm-agricultural-applications-workshop>).

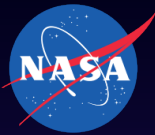




Water-Related Disease Initiative


- Scope: an effort to explore linkages and research/operational applications of NASA EOS data and water-related disease
- End Products:
 1. Workshop in Spring 2018
 2. Nov 7th Webinar: SSA/MA/ASTC
 3. End user stories, interviews, case studies
 3. New visualizations and NASA stories
 4. Activities to engage and inform the general public
 5. Online resource page with resources for general public






<https://pmm.nasa.gov/>






NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION



GODDARD SPACE
FLIGHT CENTER

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The Art of Creating Digital Hurricanes

Every day, scientists at NASA work on creating better hurricanes – on a computer screen. At NASA’s Goddard Space Flight Center in Greenbelt, Maryland, a team of scientists spends its days incorporating millions of atmospheric observations, sophisticated graphic tools and lines of computer code to create computer models simulating the weather and climate conditions responsible for hurricanes. Scientists use these models to study the complex...



TRMM

TROPICAL RAINFALL MEASURING MISSION

TRMM operated from 1997 - 2015 and carried the first on-orbit active/passive instruments to study tropical rainfall. **3842*** data will continue through mid-2017 ...more



GPM

GLOBAL PRECIPITATION MEASUREMENT

An international satellite mission launched by [NASA](#) and [JAXA](#) on Feb. 27, 2014, that is setting new standards for precipitation measurements worldwide using a network of satellites united by the GPM Core Observatory. [Get data](#)



FEATURED ARTICLES

1 2 3 4 5

LATEST HALF-HOURLY PRECIPITATION

IMERG-E 6/22/2016 15:00 UTC



Liquid Precipitation Rate (mm/hour) Frozen Precipitation Rate

.1 .2 .3 1 2 3 5 10 20 50 .1 .2 .3 1 2 3 5 10 20 50

[Download Data](#) | [Extreme Events](#) | [Precipitation Maps](#)

EXTREME WEATHER NEWS



Tuesday, June 21, 2016:
Danielle Hits Mexico And Weakens

1 2 3 4 5



Data Access: <http://gpm.nasa.gov>



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PRECIPITATION MEASUREMENT MISSIONS

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▼ Data Visualization

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[Data Tutorials](#)[Extreme Weather News](#)[Using the PPS FTP](#)

Data Visualization

[Global Viewer](#)[Precipitation and Applications Viewer](#)[NASA Worldview](#)

Data Access

particular sensor or sensor combination has been processed by GPM. For the GPM Core Observatory this is for Levels 0 through 3 products (as applicable). For the partner satellites in the GPM constellation this is Levels 1c through 3 (as applicable).

Users are encouraged to access data from the primary TRMM and GPM archives (i.e. nasa.gov domains at Goddard Space Flight Center). When data from secondary archives are used, it is incumbent on the user to verify that the data values accessed are accurate, up-to-date, current-version copies of the original data. Data format questions should be directed to the relevant archive site, while science questions should be sent to the dataset developers.

Data Updates

Thursday, October 23, 2014

NOAA Network Restored

The NOAA network is gradually being restored. MHS data appears to have started flowing around 02:00 UTC on 23 October 2014, but as of 08:00 UTC on 23



Near real-time precipitation viewer



Data Access

Training

Data Tutorials

Extreme Weather News

▼ Data Downloads & Documentation

GPM

TRMM

Ground Validation

▼ Data Visualization

Global Viewer

Precipitation and

Applications Viewer

NASA Worldview

Data Sources

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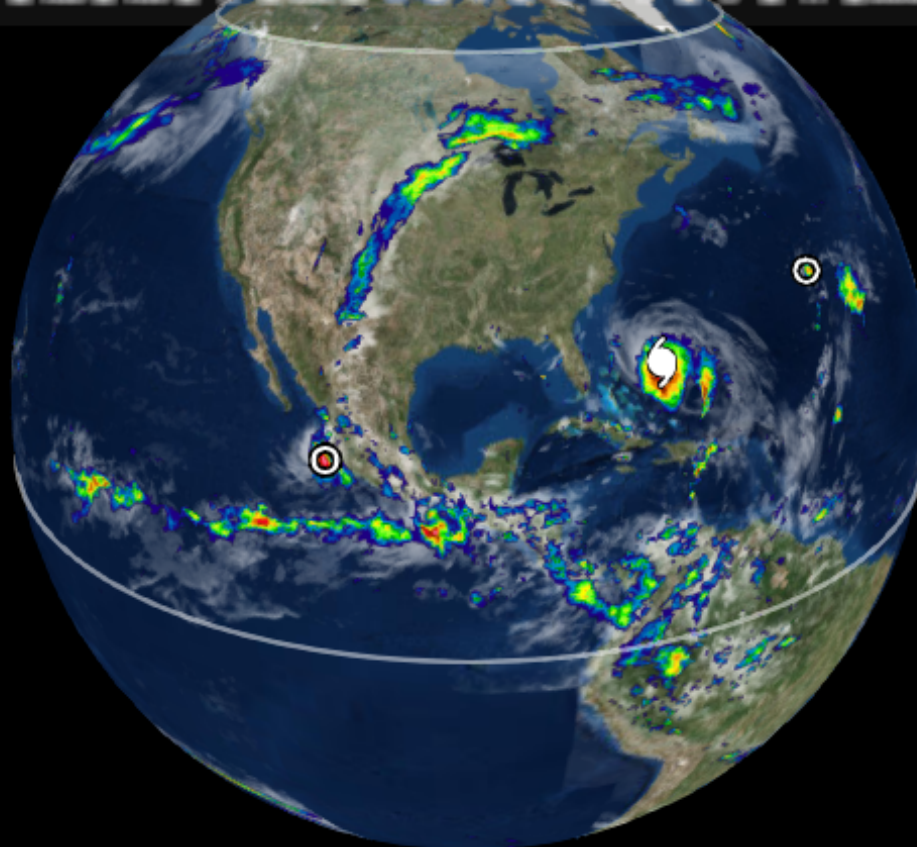
Facebook



Youtube

Global Precipitation Viewer

Precipitation Accumulation - 24 Sep 2017 0230 UTC - 24 Hours



NASA-GPM • Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



GPM Data Publisher



A new publisher provides IMERG rainfall, Landslide, and Flood Nowcasts via Applications Programming Interface. Data are available in a variety of different formats and end users can access products directly from the website or via the API publisher to automate data access.

- **Available datasets:**

- IMERG 30mn, 3hr, 1day, 7day
- Flood Nowcast (GFMS, U of MD)
- Global Landslide Nowcast Model (NASA)

GPM IMERG "Early Run" 30 Minute Precip. Accumulation
GPM IMERG "Early Run" 3 Hour Precip. Accumulation Updated Every 30 minutes
GPM IMERG "Early Run" 1 Day Precip. Accumulation Updated Every 30 minutes
GPM IMERG "Late Run" 1-Day Precip. Accumulation
GPM IMERG "Late Run" 3-Day Precip. Accumulation
GPM IMERG "Late Run" 7-Day Precip. Accumulation
Floods Nowcast
Global Landslide Nowcast
Global Landslide Nowcast Updated Every 30mn

PRECIPITATION MEASUREMENT MISSIONS

Download Data:

Download:

Export:

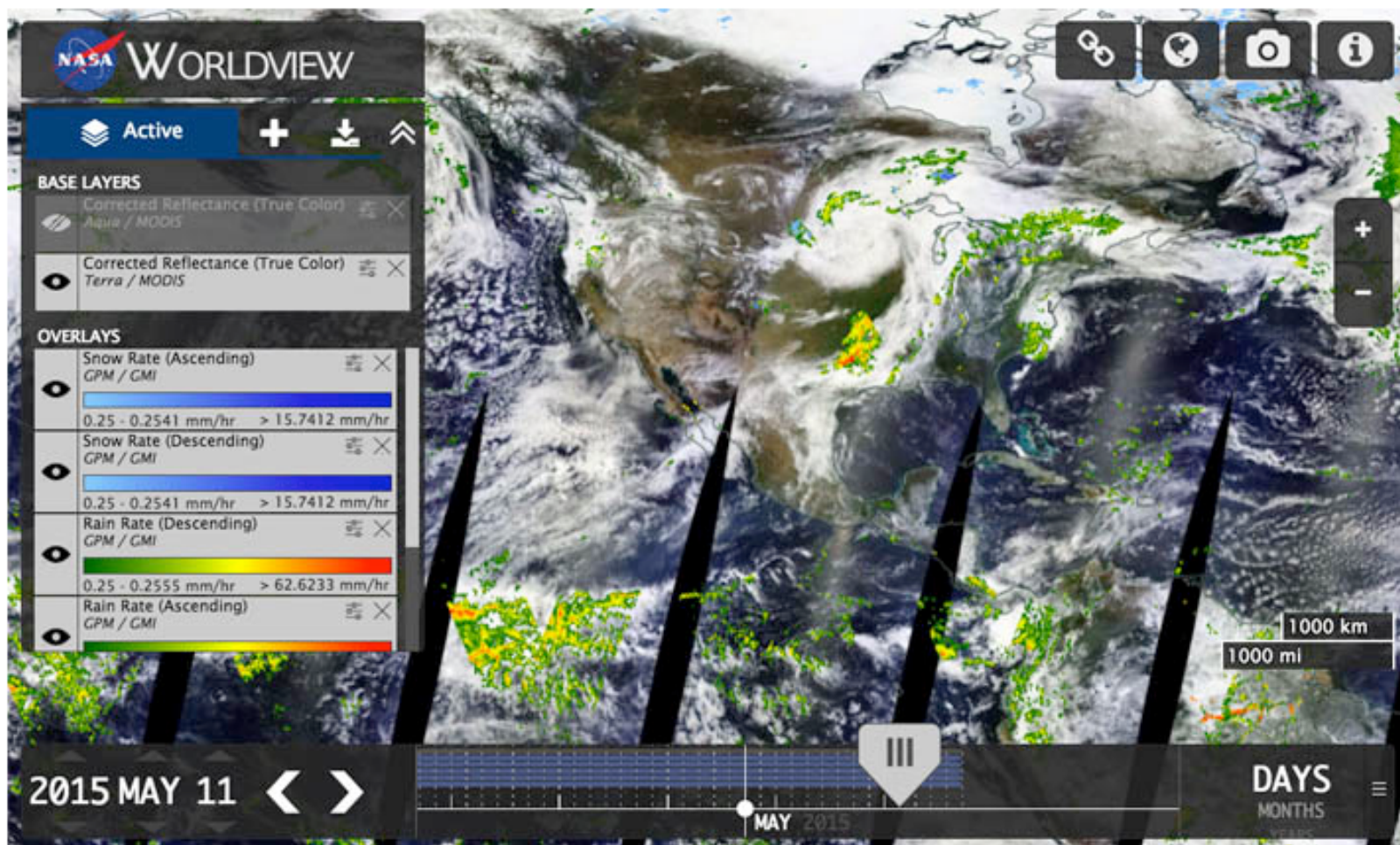
- geoJSON
- topoJSON
- TIF
- arcJSON
- -

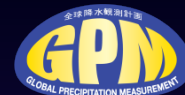
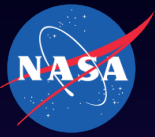
<https://pmm.nasa.gov/precip-apps>



NASA Worldview

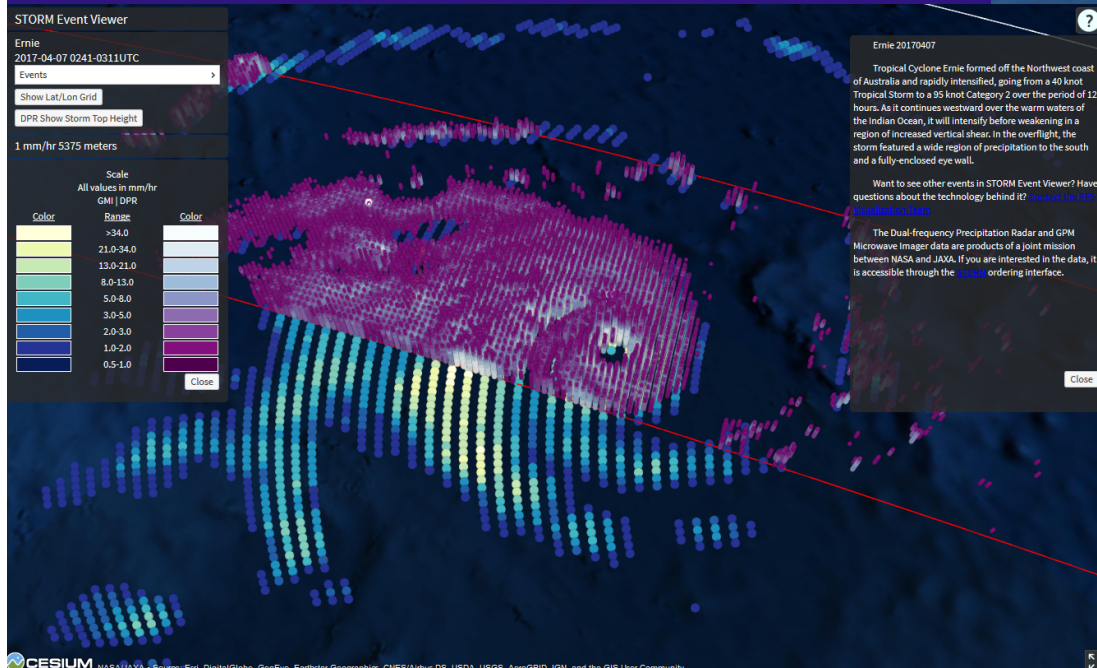
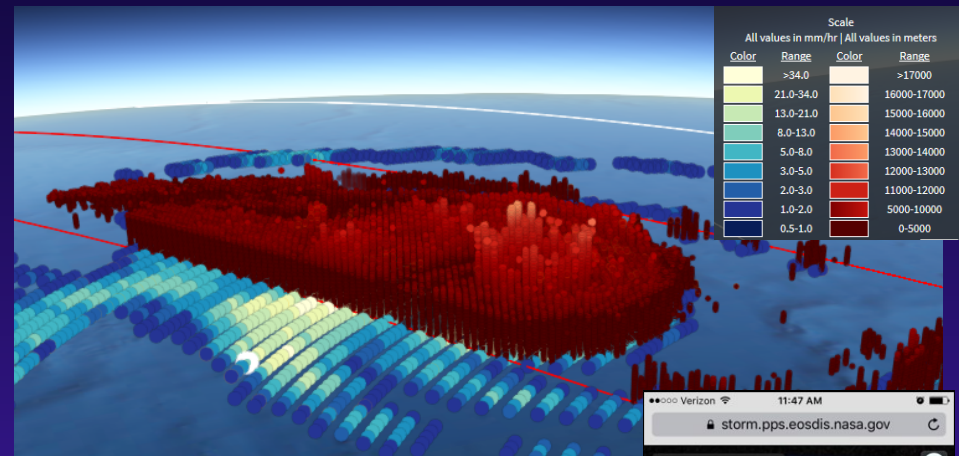
NASA Worldview





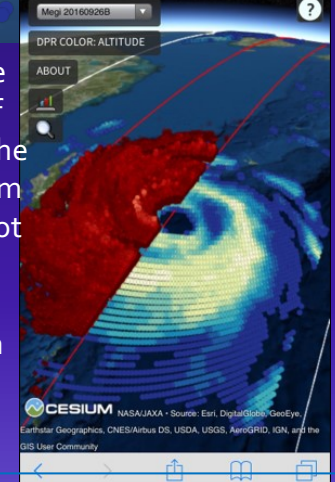
New ways to interact with extreme storms observed by GPM

A STORM Event Viewer developed by the Precipitation Processing System at GSFC allows users to view 2D GPM Microwave Imager (GMI) and 3D Dual-frequency Precipitation Radar (DPR) data from the latest extreme weather events on an interactive 3D globe in your web browser. It is also compatible with mobile devices.



Top and left: Tropical Cyclone Ernie captured by GPM on 04-07-2017 off the Northwest coast of Australia. The storm rapidly intensified, going from a 40 knot Tropical Storm to a 95 knot Category 2 over the period of 12 hours.

Right: Super Typhoon Megi as seen by GPM on 9-26-2016 (shown on a smartphone)




Access the STORM Event Viewer at:

<https://storm.pps.eosdis.nasa.gov/storm/cesium/EventViewer.html>


For other data visualization tools, please visit:

<https://pmm.nasa.gov/data-access/visualization>


<https://pmm.nasa.gov/education>



Precipitation Education

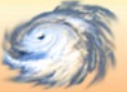


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Water Cycle

The continuous movement of water on, above and below Earth's surface.




Weather & Climate

The atmospheric conditions that lead to our daily weather and global climate.



Technology

The spacecraft, instruments and people that study Earth systems.



Societal Applications

How studying our planet's rain and snowfall makes the world a better place.

Why Measure Rain and Snow?

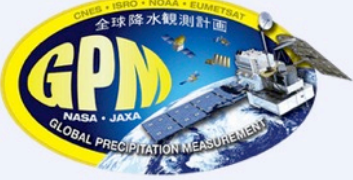
Rain, snow, and other forms of precipitation affect every part of life on Earth. Rain falls on the crops we eat, fills the reservoirs of water we drink, and is an integral part of everyday weather and long term climate trends. This website, presented by NASA's Global Precipitation Measurement (GPM) mission, provides students and educators with resources to learn about Earth's water cycle, weather and climate, and the technology and societal applications of studying them.

New to the site? [Click here for a quick video tour.](#)

The GPM Core Observatory successfully launched on February 27th, 2014, [learn more.](#)

Global Precipitation Measurement

GPM is an international satellite mission that uses multiple satellites orbiting Earth to collect rain, snow and other precipitation data worldwide every three hours. On February 27th, 2014, NASA and the Japan Aerospace Exploration Agency (JAXA) launched a Core Observatory satellite carrying advanced instruments that improve our precipitation-measuring capabilities and bring all the data from the partner satellites into a unified global dataset.



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November 2015 - February 2016

The Olympic Mountain Experiment (OLYMPEX)



More to do...

- GPM Applications team will continue to engage the user community by thematic areas as well as sectors
- Case studies of existing users and possibly new adopters will help to expand our portfolio and provide qualitative and (hopefully) quantitative examples of how GPM data is supporting decision making as well as where we can improve
- We are always looking for suggestions, feedback, and new ideas!